

# EXPR<sub>e</sub>S: Operationalizing e-VLBI

- The final stages of the project and next steps

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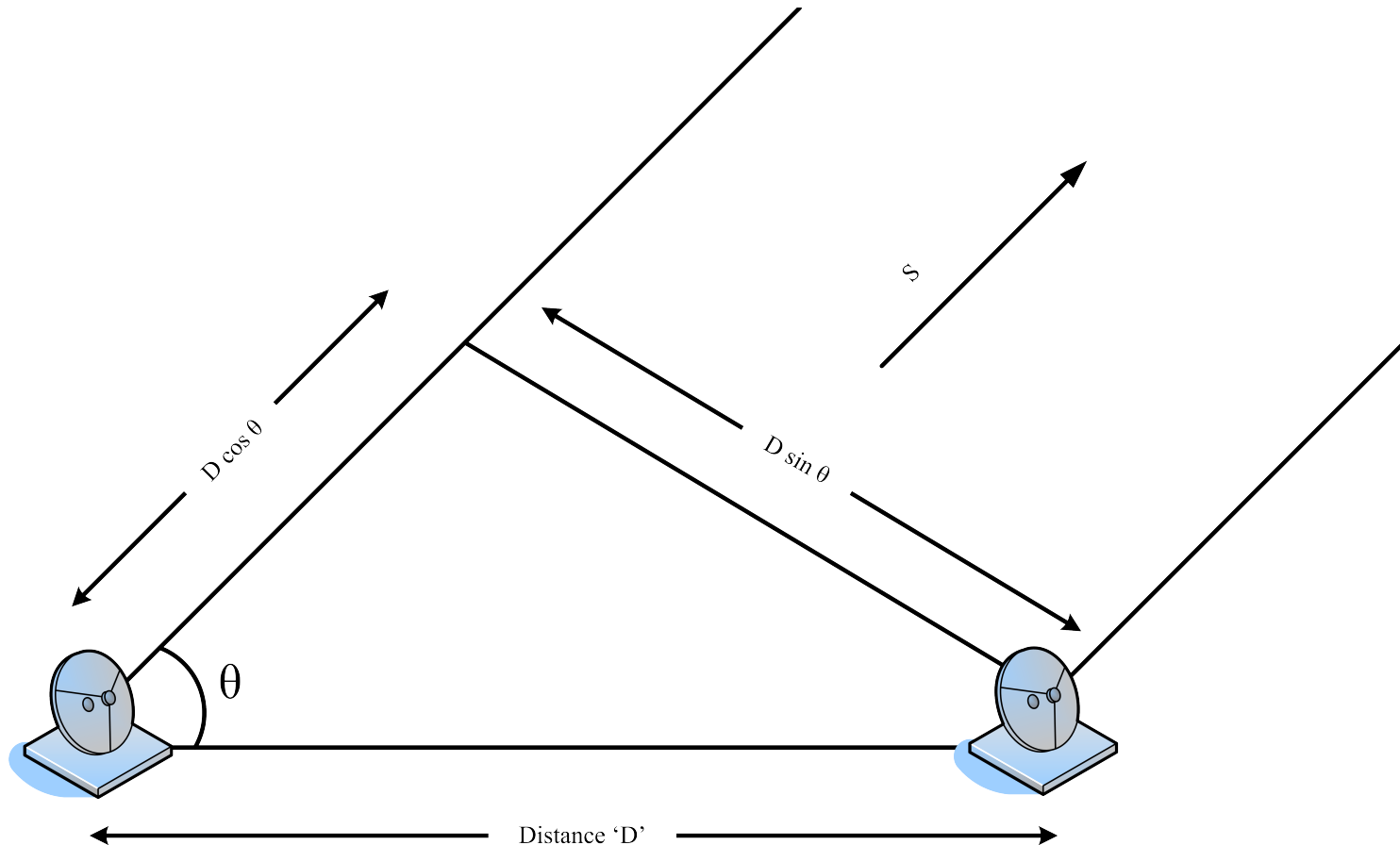


# Overview

- Radio astronomy, e-VLBI and the EXPReS Project
- Project Goals
- Progress: Network & Computation
- Next Steps
- Conclusion/Q&A

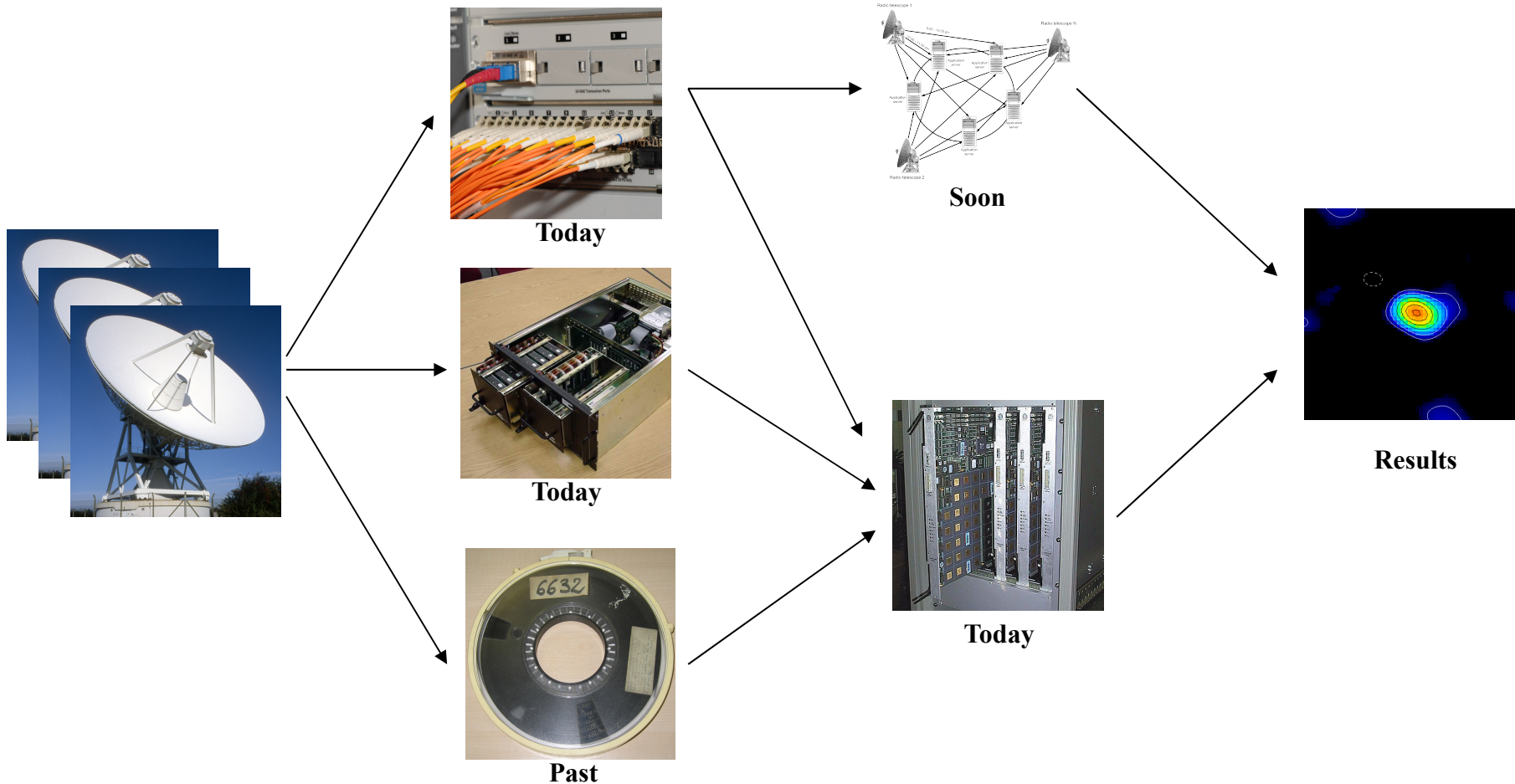
# Explaining e-VLBI in Two Slides (1)

- Astronomy → Radio Astronomy
- Single Antenna → Multiple Antenna Arrays



# Explaining e-VLBI in Two Slides (2)

- Observing as: Single Dish  $\rightarrow$  VLBI  $\rightarrow$  e-VLBI





# EXPReS Project

- EXPReS is made possible by the European Commission (DG-INFOS), Sixth Framework Programme, Contract #026642
- Project Details
  - Three year, started March 2006
  - International collaboration
  - Funded at 3.9 million EUR
- Means: high-speed communication networks operating in real-time and connecting some of the largest and most sensitive radio telescopes on the planet

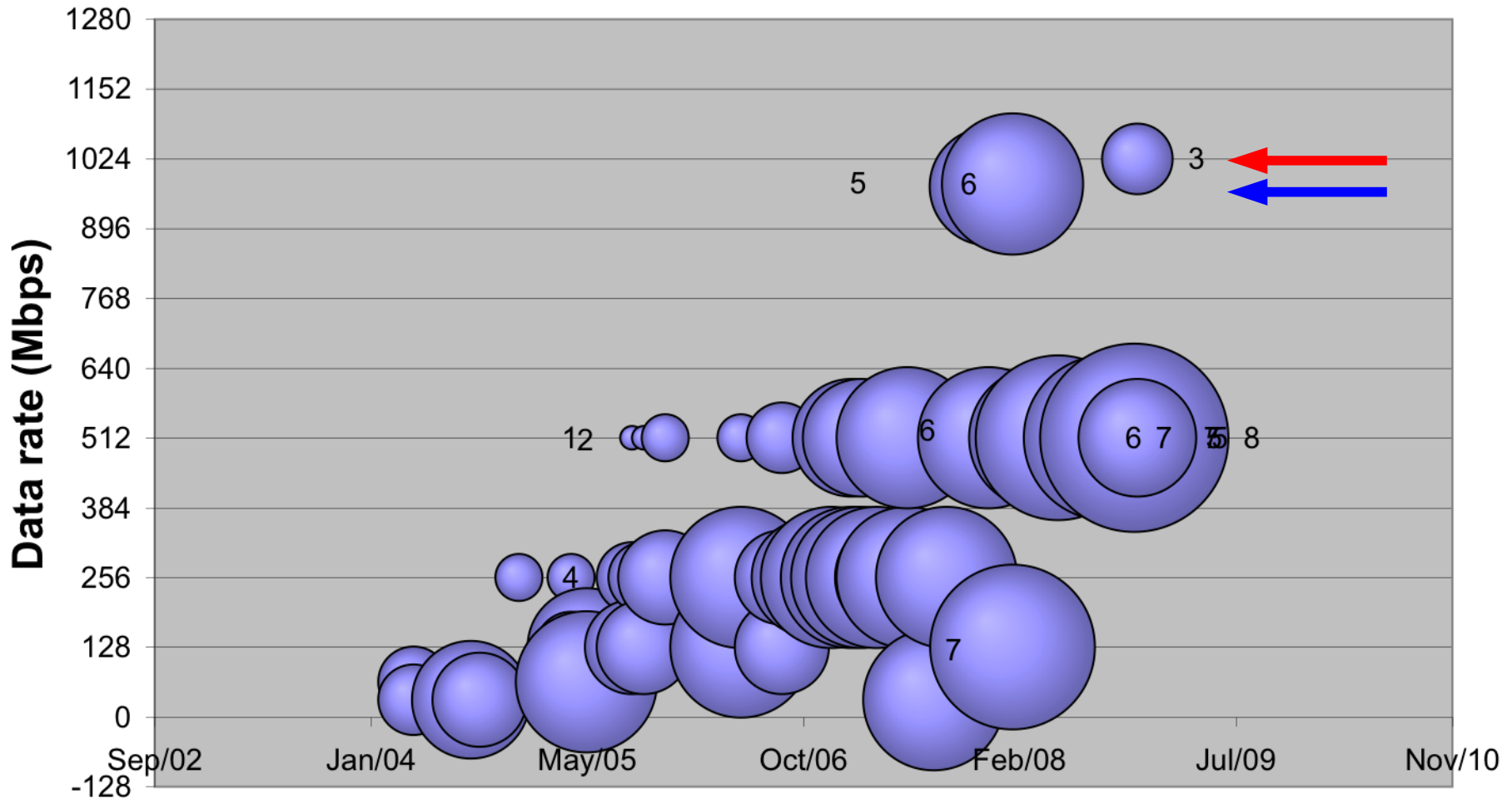
# Status of the e-EVN



Network status as per 2008-05-02. Image created by Paul Boven <boven@jive.nl>. Satellite image: Blue Marble Next Generation, courtesy of Nasa Visible Earth (visibleearth.nasa.gov).

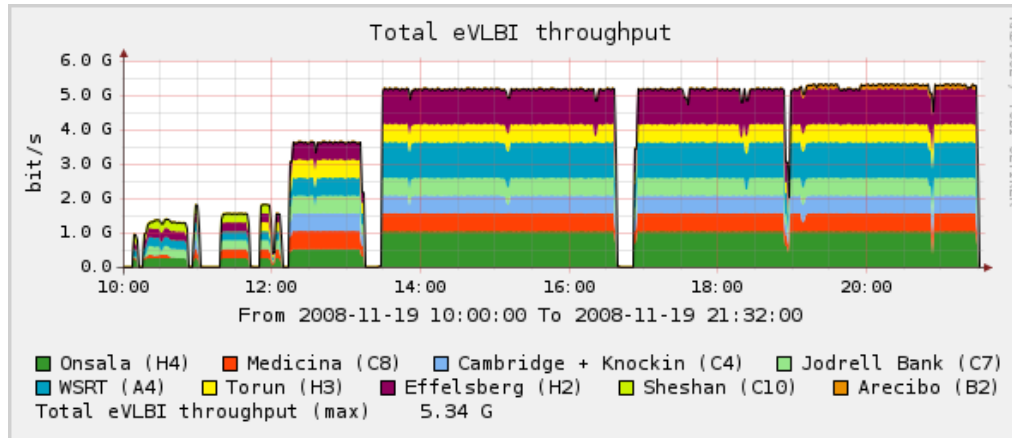
# Increased Operational Bandwidth

Number of telescopes @ data rate



# Support Software

- Cacti Network output displaying 1024 Mbps throughput for multiple stations

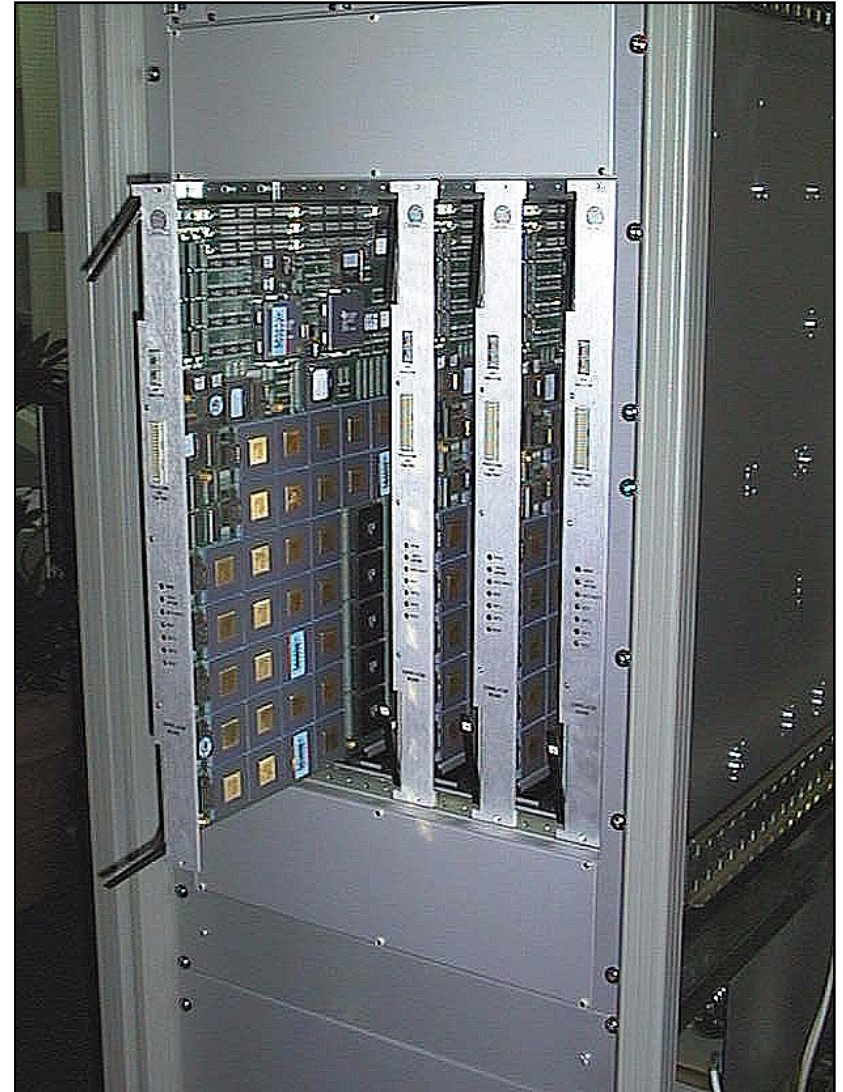


- e-VLBI streams increase in  $2^n$  bitrate "octaves"
  - Note that  $1024 > 1000$
  - a non-minor effort was put into several different efforts to allow e-VLBI to work at 1000 Mbps and 1024 Mbps



# Current Correlator

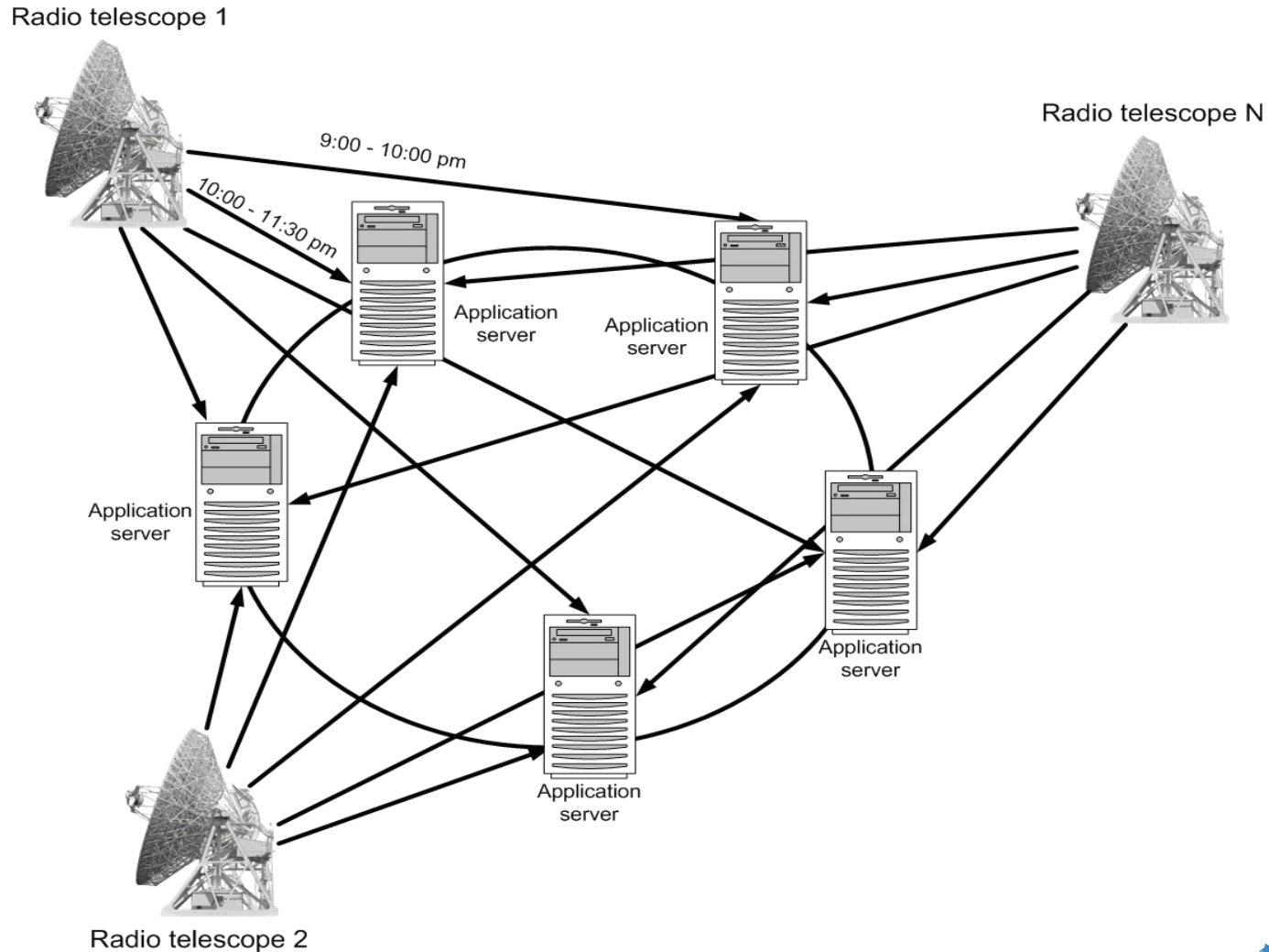
- Currently custom hardware
  - "Faster" than an IBM Blue Gene/S
- Quickly aging, hard to repair, no replacement parts, requires a great deal of human interaction to complete correlation



# Next Generation Correlator

- Software correlator
  - Improves upon existing correlator design, flexible, takes advantage of Moore's law
- Can take advantage of grids, with caveats
- "The Grid" might not be powerful enough
- Operational issues
  - grid friendly- "bursty" need for large computation
  - grid mean- desired 24x7 usage

# Diagram of Grid Correlation



# Partnerships are critical

- Astronomers are not computer scientists, co-lo centers, network engineers, archivists, environmental analysts, etc
- Computational
  - Returning to first principles- how much energy is required to flip the bits for computation? From this, it is "easy" to determine the size of the next correlator and the energy consumption/computational throughput required
- Storage
  - Is it truly unreasonable to ask for multi-petabyte, transient storage at line-speed I/O?
- Network
  - Ongoing quest for the last mile; network speeds and user desires continually evolve; thus *the last mile continues to get longer*. Europe is making steady progress; almost all other areas are slower



# e-Infrastructures and Science

- Fundamentally, what are the characteristics of applications that will drive the future infrastructure?
  - Networking
    - Speed, last mile
  - Computation
    - Scales with networking
  - Storage
    - Buffer, storage, archive
- Science goals
- Public Benefit
- Public Relations
- ???

# Questions/Answers

- Contact information

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- Additional Information

<http://expres-eu.org/>  
<http://www.jive.nl/>

[note: only one “s”]

- EXPR<sub>e</sub>S is made possible through the support of the European Commission (DG-INF<sub>SO</sub>), Sixth Framework Programme, Contract #026642



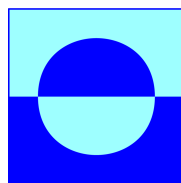
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